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Montana's Ground Water Resources

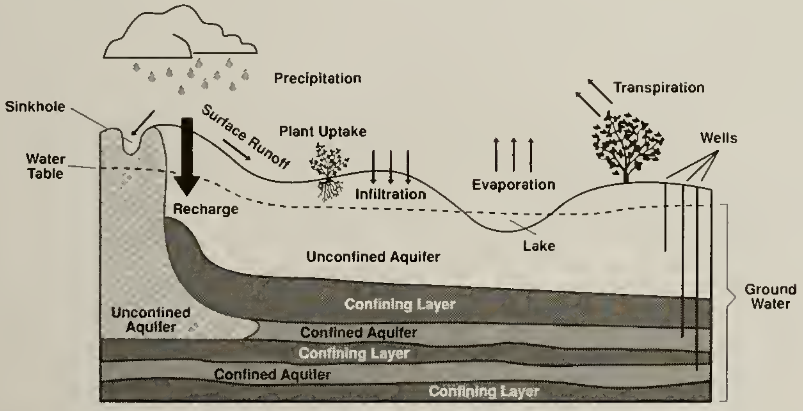
An Overview of Montana's Ground Water

Beneath the earth's surface lies Montana's greatest supply of fresh water. Ground water constitutes the major source of drinking water for half our population. When some people think of ground water, they imagine large underground lakes or intricate systems of subsurface rivers, but this is not the case. In fact, ground water is simply water that fills pores, channels, or cracks in permeable rocks beneath the surface of the earth. Once thought to be inexhaustible and safe from contamination, these reserves now face depletion and impairment.

Ground Water and Geology

The availability of ground water is closely linked to geology and is influenced by both regional and local geological conditions. **Geology** is usually associated with the rock, the nature of the deformation of the rock in the area, and the sediment (the soil) above the rock which forms surficial deposits. The rock is generally hard and consolidated, while the sediment is composed of weathered and broken unconsolidated material. Ground water fills the open spaces in rock and sediment. Such open spaces are called **voids or pore spaces.** Voids or pore spaces exist between soil particles, in the spaces between the grains of sand and gravel, cracks in solid rocks, and solution cavities in carbonate rocks (such as limestone).

Two terms of great importance in ground water geology are **porosity** and **permeability.** Porosity is a measure of the voids in a material (rock, gravel, sand or clay). Permeability is a measure of the material's ability to transmit water. Porosity is defined as the percentage of rock or soil that is void of materials. In general, the greater the porosity and the larger the pores or voids, the greater the permeability. However, a rock may be highly porous, but ground water will only move slowly through it if the pore spaces are extremely small. For example, shale and clay may contain as much water as half their total volume. Yet, the water will not flow through these materials at any appreciable rate.



Water movement on the land surface and in the soil (Miller, 1993).

Most ground water comes from precipitation that falls on the ground and percolates below the soil. Unlike surface water, however, the amount of ground water in an underground reservoir does not depend on a single year's precipitation, but on the total recharge over many years.

Surface and ground water are in motion and are a part of the hydrologic cycle.

Of the precipitation falling on land; some returns to the atmosphere by direct evaporation from the soil or water surface and by transpiration (water vapor emitted by plants during growth). Yet, some precipitation returns to the seas as runoff and some percolates below the surface to become part of the ground water reservoir. Water that has migrated downward due to gravity to the **zone of saturation** below the water table, where all the voids are filled, is distinguished from the unsaturated zone where all the pores are not filled. The unsaturated zone is above the saturated zone and is also called the **zone of aeration** or **vadose zone.** Movement through this zone is controlled by molecular or capillary forces. Water in the saturated zone is ground water, which does not include the soil, vadose or gravitational water above the water table. Aquifers may be classified as **unconfined** or **confined** depending upon how it occurs.

An unconfined aquifer occurs beneath the water table in unconsolidated materials (gravels, sands and clays) and sometimes in bedrock. Normally, shallow ground water moves slowly and flows in the direction the land slopes. The water table roughly parallels the land surface but is typically a little deeper on hilltops and a little shallower in valley bottoms. The water occasionally may intersect the land surface in valleys and depressions. When it does, ground water may discharge as a spring, or into a bog, pond or stream. An aquifer is a water-bearing formation that transmits water in sufficient quantity to supply wells or springs. Unconfined aquifers are the most susceptible to impairment. These aquifers are not protected by an

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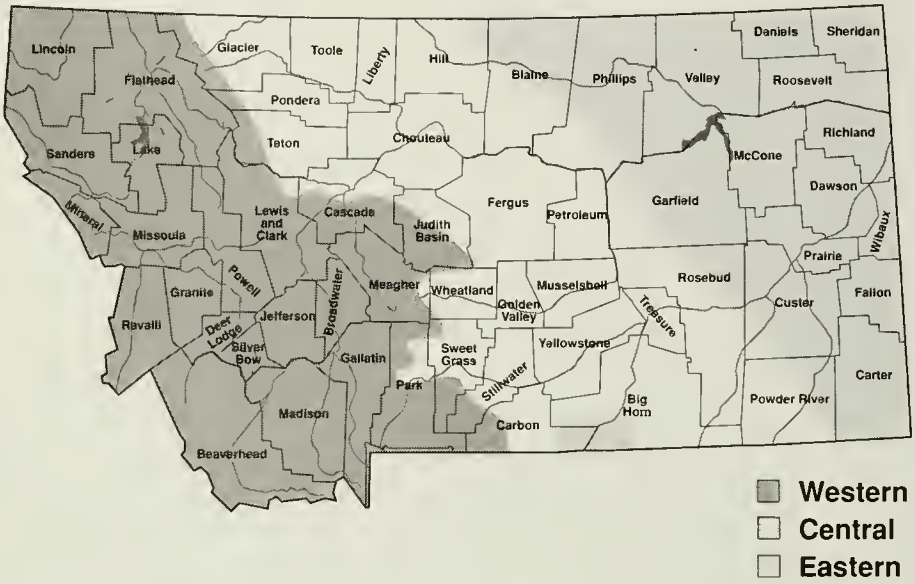

Montana divided into three divisions each characterized by certain conditions of topography, climate and geology (Groff, 1958).

overlying layer of impermeable material and may occur fairly close to the land surface. The volume of water available in unconfined aquifers will fluctuate with usage and with seasonal replenishment or "recharging" of the source by precipitation.

In contrast to this type of aquifer is the **confined aquifer** which is bound on top and bottom by layers of relatively impermeable material. Confined aquifers are permeable beds lying between slowly impermeable beds or **aquitards** (more commonly called "confining layer"). The aquitard holds the water in the aquifer under pressure. Some confined aquifers have no recharge zone at all and must be recognized as a resource which cannot be replenished. When a well taps into a confined aquifer and the water in the well rises above the top of the aquifer it is called an **artesian** well; the water may or may not flow at the surface. An artesian aquifer is often supplied by infiltration from precipitation in the recharge area which may be many miles distant from the well site and the movement of water from the recharge area to the discharge location may require days or centuries.

The Western Mountain Ranges encompass the mountainous areas of the northwestern, western and southwestern parts of Montana. The nonglaciated Central Region in Montana contains isolated mountain ranges in Central Montana (west of the Judith, Big Snowy and Crazy Mountains), and the more subdued topography of the region most people think of when discussing the Great Plains. The glaciated Central Region is similar to the nonglaciated Central Region, but is covered by a veneer of glacial deposits. Montana is divided slightly different to better distinguish the western mountains from the central plains and mountains and the eastern plains.

Ground Water Importance

Many types of human activities disrupt the natural equilibrium of an aquifer — affecting both the quality of an aquifer and the quality and the quantity of ground water. Population pressure, increased per capita use and impairment of surface water supplies have forced many communities to turn to ground water. As ground water becomes increasingly important to meet future water resource needs, gather information about your aquifer or aquifer system.

- Obtain a ground water map from the United States Geological Survey.
- What area does the aquifer cover? What jurisdictions does it cover? How many citizens does it serve? What percentage is used for residential, commercial, industrial, or agricultural purposes?
- Where are the critical recharge zones? How is the land above them used ? What geological characteristics affect their permeability?
- According to the United States Geological Survey estimates, how much water is pumped out each year relative to recharge? What is the "safe yield" for this aquifer system? Has the water table dropped in recent years? Why?
- Has your aquifer been mapped for location, overdraft and vulnerability to contamination?

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The programs of the Montana Extension Service are available to all people regardless of race, creed, color, sex or national origin.

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